

# Probing Ion Interactions with Phospholipid Membranes



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This talk explores the binding of cations to phospholipid bilayers. The measurements were made by vibrational sum frequency spectroscopy and epifluorescence microscopy using microfluidic platforms. It was found that metal cations interact with lipid head groups in a wide variety of ways. For example, alkali metal cations (e.g.  $K^+$ ,  $Na^+$ ,  $Li^+$ ) interact only weakly with the negatively charged carboxylate and phosphate groups. Specifically, the equilibrium dissociation constant,  $K_d$  with negatively charged lipids, such as phosphatidylserine (PS), phosphatidic acid (PA), and phosphatidylglycerol (PG), is in the high millimolar range. Alkaline earth metal cations like  $Mg^{2+}$  and  $Ca^{2+}$  have  $K_d$  values that are at least two orders of magnitude lower for the same groups on PS, PA, and PG lipids. All of these cations cause substantial changes to the interfacial water structure and follow a direct Hofmeister series with the most strongly hydrated cations binding more tightly than the most weakly hydrated cations. Significantly,  $Ca^{2+}$  will form contact ion pairs with phosphate moieties. This can lead to bridging interactions between lipids that substantially alter lipid head group orientation. By contrast,  $Mg^{2+}$  does not form contact ions pairs with phosphate, and therefore does not bridge multiple lipids together nearly as effectively. Finally, transition metal ions can bind to amine moieties on PS and phosphatidylethanolamine (PE) lipids according to the Irving-Williams series. The tightest known coordination complex is formed between two PS lipids and 1  $Cu^{2+}$ , which has an apparent  $K_d$  value in the low picomolar range.

**Meet the Speaker, 2:15 – 3:00pm, Student Lounge, 3144**